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(54) A method and apparatus for compacting a powder material into a homogeneous article

(57) The invention relates to a method for compacting a powder material into a homogenous article. According to the invention the method comprises the steps of;

placing the powder material in a moulding cavity (5) connected to a gas source, blowing gas into the lower end of the moulding cavity (5) so that the particles in the powder material are suspended in a gas stream,
sealing the upper end of the moulding cavity (5) by an upper pressing punch (3), connecting the lower end of the moulding cavity (5) to a vacuum source, sealing the connection (6,7) to the vacuum source by moving a lower punch (4) relative to the lower end portion of the moulding cavity (5), and
thereafter compacting the powder material with the help of the pressing punch (3).

The invention also relates to an apparatus for performing the method.

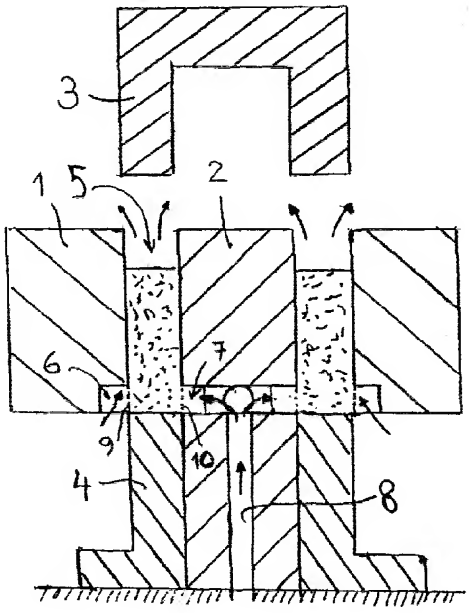

FIG. 1

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Description

TECHNICAL AREA

[0001] The present invention relates to a method and an apparatus for compacting a powder material into a homogenous article.

BACKGROUND TO THE INVENTION

[0002] In processes for manufacturing articles, such as bearing rings, bushes, solid bodies, etc, by compacting powder materials in a moulding cavity it is essential that the powder be evenly distributed within the moulding cavity before the start of the pressing operation. However, it is difficult to fill a moulding cavity with powder so that the particles in the powder are uniformly distributed and so that the upper surface of the powder material filling the moulding cavity is horizontal. Moreover, if the pressing operation takes place with a very high pressing rate so that the pressing time is in the order of a few milliseconds it is a great risk that air is entrapped in the compacted article, disturbing the homogeneity thereof.

[0003] The object of the present invention is to solve these problems by providing a method and an apparatus for compacting a powder material into a homogenous article in which the particles in the powder are evenly distributed within the moulding cavity and the upper surface of the powder in the moulding cavity is horizontal before the start of the pressing step.

SUMMARY OF THE INVENTION

[0004] This object is accomplished by a method for compacting a powder material into a homogenous article, characterised by the steps of; placing the powder material in a moulding cavity connected to a gas source, blowing gas into the lower end of the moulding cavity so that the particles in the powder material are suspended in a gas stream,
sealing the upper end of the moulding cavity by an upper pressing punch, connecting the lower end of the moulding cavity to a vacuum source,
sealing the connection to the vacuum source by moving a lower punch relative to the lower end portion of the moulding cavity, and
thereafter compacting the powder material with the help of the pressing punch.

[0005] In a preferred embodiment the vacuum source creates a sub-pressure in the moulding cavity of at least half the atmospheric pressure.

[0006] The invention relates also to an apparatus for compacting a powder material into a homogenous article comprising a moulding cavity having vertical side walls and open ends, and an upper and a lower punch having the same cross-sectional area as the moulding cavity and being movable into and out of the moulding cavity, characterised in that an opening is arranged in the side wall of the moulding cavity in the lower end part thereof, said opening being connected to a device for blowing gas into and a device for sucking gas out of the moulding cavity, and that the lower punch is movable relative to the moulding cavity from a first position in which the upper end surface of the punch is located below the opening and a second position in which the opening is covered by the side wall of the lower punch.

[0007] In a preferred embodiment a gas-pervious membrane covers the opening, said membrane being impervious for the smallest of the particles in the powder material to be placed in the moulding cavity. Preferably, the vertical walls of the moulding cavity consist of the inner wall of a matrix having the form of a hollow cylinder and the side wall of a cylindrical core pin concentrically located in the inner space defined by the hollow matrix, and the upper and lower punch has a lower respectively an upper end surface comprising an annular flange fitting into the annular moulding cavity, the opening connected to a device for blowing gas into and a device for sucking gas out of the moulding cavity comprising an annular groove in the lower end portion of the inner wall of the matrix and/or the side wall of the core pin.

BRIEF DESCRIPTION OF THE DRAWING

[0008] The invention will now be described with reference to the enclosed Figures, of which;

Fig. 1 schematically shows a cross-sectional view of an apparatus according to a preferred embodiment of the invention, during the fluidising step,

Fig. 2 shows the apparatus of Figure 1 during the vacuum step, and

Fig. 3 shoes the apparatus of Figure 1, immediately before the start of the compacting step.

DESCRIPTION OF EMBODIMENTS

[0009] An apparatus for compacting powder into solid annular articles, such as bearing rings, is shown in Figures 1-3. The apparatus comprises a hollow cylindrical matrix 1, a core pin 2, an upper pressing punch 3 and a lower punch 4. The core pin 2 is cylindrical and concentrically disposed in relation to the matrix 1 so that the side walls of a moulding cavity 5 is defined by the inner wall of the matrix and the side wall of the core pin. The bottom wall of the moulding cavity 5 is defined by the upper end surface of the lower punch 4 having the form of a hollow cylinder fitting into the annular space between the inner side wall of the matrix and the side wall of the core pin. The upper punch 3 has the form of a hollow cylinder with a closed upper end.

[0010] The matrix 1 has an annular groove 6 in the lower end portion thereof. The groove 6 is by suitable

conduits in communication with a gas source (not shown in the Figures). Opposite to the groove 6 a similar annular groove 7 is made in the core pin 2. This groove 7 is also in communication with the gas source by suitable conduits. In the embodiment shown the groove 7 is connected to a central bore 8 by at least two radial bores. The central bore 8 is by a suitable conduit connected to the same gas source as the groove 6. The side of the respective groove 6,7 that is turned against the moulding cavity 5 is closed by a gas-permeable membrane 9 and 10, respectively.

[0011] In Figure 1 the apparatus is shown in the beginning of the compacting process immediately after powder material has been introduced into the moulding cavity 5. In order to accomplish an even distribution of the particles in the powder material filled into the moulding cavity, gas is blown into the moulding cavity by the gas source, as is indicated by arrows in Figure 1. The flow rate of the gas is such that a fluidised bed is accomplished, i.e. the particles in the powder material are suspended by the gas flow. Thereby an even distribution of the particles in the powder material and a horizontal upper particle surface will be established. The flow rate for creating a fluidised bed is dependent of the density, size and form of the particles in the powder material.

[0012] In the described embodiment the gas flow is created after the filling of the moulding cavity with powder material. When the gas flow first reaches the bottom of the moulding cavity, it has a stirring effect on the powder material in the moulding cavity that ensures an even distribution of the particles in the powder material when a flow rate sufficient for suspending the particles of the powder material is reached. It is pointed out that the flow rate should be successively increased in order to avoid a sudden increase of pressure in the moulding cavity, which might result in that some of the particles in the moulding cavity will be thrown out from the moulding cavity.

[0013] Alternatively, the gas flow in the moulding cavity is created immediately before the moulding cavity is filled with powder material. In such a case, the pressure drop over the moulding cavity will successively increase during the filling of the moulding cavity so there will be no risk of a sudden pressure increase therein.

[0014] In the case when the filling of the moulding cavity takes place before the gas flow is created, the lower punch 4 is preferably moved upwards from the position shown in Figure 1 so that the upper surface of the powder material filled into the moulding cavity will lie flush with the upper surfaces of the core pin and the matrix. Superfluous powder material filled into the moulding cavity can then be scraped of. Thereafter, the lower punch is moved downwards to the position shown in Figure 1 and the gas flow is created.

[0015] The gas used can be air or an inert gas.

[0016] After having achieved a fluidising of the particles in the moulding cavity 5, the gas flow is stopped. At the same time the upper punch 3 is moved downwards into the upper end of annular space so that the upper end of this space is sealed of from the surrounding atmosphere. The grooves 6 and 7 are put in communication with a vacuum source (not shown in the Figures). The gas in the moulding cavity will thus be drawn out thereof and the evenly distributed particles in the powder material filling the mould will come into abutment with each other. The sub-pressure created in the moulding cavity is at least half the atmospheric pressure. It is pointed out that the membranes 9,10 is so fine that no particles can pass through the membranes into the grooves 6,7. This step in the process of compacting a powder material into a homogenous article is shown in Figure 2, the sucking of gas out of the moulding cavity being indicated by arrows.

[0017] In order to ensure the sealing of the moulding cavity from the surrounding atmosphere during the during the sub-pressure step, it usually appropriate to provide sealing elements (not shown in the figures) between the matrix and the upper and lower punch, respectively. The sealing element for the lower punch is preferably fixed to the matrix whereas the sealing element for the upper punch is slidably attached to the upper punch and pretensioned to a position in which the sealing element lies flush with the lower surface of the upper punch.

[0018] Thereafter, the lower punch 4 is moved upwards such a distance that the grooves 6,7 are covered by the outer side wall thereof and the grooves 6,7 are disconnected from the vacuum source. The powder material in the moulding cavity will move upwards together with the lower punch 4 and in the end position of the lower punch, which is shown in Figure 3, the upper surface of the powder material is in abutment with the lower end surface of the upper punch 3.

[0019] The apparatus is now ready for the compacting of the powder material in the moulding cavity and a the pressing punch 3 is driven downwards with a force P, as indicated by an arrow in Figure 3. The pressing punch is driven with a very high pressing rate, the pressing operation will only take a few milliseconds.

[0020] The lower punch 4 is advantageously arranged to eject the compacted article out of the moulding cavity 5 after the pressing step has been performed.

[0021] In the embodiment described openings 9,10 are present in both the matrix and the core pin. In an alternative embodiment (not shown), the openings are only provided in the matrix. In such a case it is possible to make the matrix movable in relation to the lower punch in order to open and close this opening. Such an alternative would facilitate the support of the lower punch during the pressing operation.

[0022] As stated in the beginning, the invention can also be performed for compacting articles into solid bodies, such as a cylinder. In such a case, the apparatus does not include a core pin so that openings would only be present in the matrix, which then preferably is movable in relation to the lower punch in order to close and

open the openings to the moulding cavity.

[0023] The embodiment described can be modified in several ways within the scope of the invention. The grooves 6,7 can for example be connected to different gas and vacuum sources, but preferably they are connected to the same gas and vacuum source. The respective gas and vacuum source can for example be the outlet and the inlet, respectively of a blower but it is also possible to use separate sources for creating the flow of gas and the vacuum. Moreover, the moulding cavity can have another form so that articles with other shapes than rings can be made, for example tubes with a rectangular or U-shaped section. The invention should therefore only be restricted by the wording of the enclosed patent claims.

Claims

1. A method for compacting a powder material into a homogenous article, **characterised by** the steps of;

   placing the powder material in a moulding cavity (5) connected to a gas source, blowing gas into the lower end of the moulding cavity (5) so that the particles in the powder material are suspended in a gas stream,
   sealing the upper end of the moulding cavity (5) by an upper pressing punch (3), connecting the lower end of the moulding cavity (5) to a vacuum source,
   sealing the connection (6,7) to the vacuum source by moving a lower punch (4) relative to the lower end portion of the moulding cavity (5), and
   thereafter compacting the powder material with the help of the pressing punch (3).

2. The method according to Claim 1, **characterised in that** the vacuum source creates a sub-pressure in the moulding cavity (5) of at least half the atmospheric pressure.

3. An apparatus for compacting a powder material into a homogenous article comprising a moulding cavity (5) having vertical side walls and open ends, and an upper (3) and a lower punch (4) having the same cross-sectional area as the moulding cavity and being movable into and out of the moulding cavity, **characterised in that** an opening (6,7) is arranged in the side wall of the moulding cavity (5) in the lower end part thereof, said opening being connected to a device for blowing gas into and a device for sucking gas out of the moulding cavity, and that the lower punch (4) is movable relative to the moulding cavity from a first position in which the upper end surface of the punch is located below the opening and a second position in which the opening is covered by the side wall of the lower punch.

4. The apparatus according to Claim 3, **characterised in that** a gas-pervious membrane (9,10) covers the opening, said membrane being impervious for the smallest of the particles in the powder material to be placed in the moulding cavity (5).

5. The apparatus according to Claim 4, **characterised in that** the vertical walls of the moulding cavity (5) consist of the inner wall of a matrix (1) having the form of a hollow cylinder and the side wall of a cylindrical core pin (2) concentrically located in the inner space defined by the hollow matrix, and the upper (3) and lower punch (4) has a lower respectively an upper end surface comprising an annular flange fitting into the annular moulding cavity, the opening (9,10) connected to a device for blowing gas into and a device for sucking gas out of the moulding cavity comprising an annular groove in the lower end portion of the inner wall of the matrix and/or the side wall of the core pin.

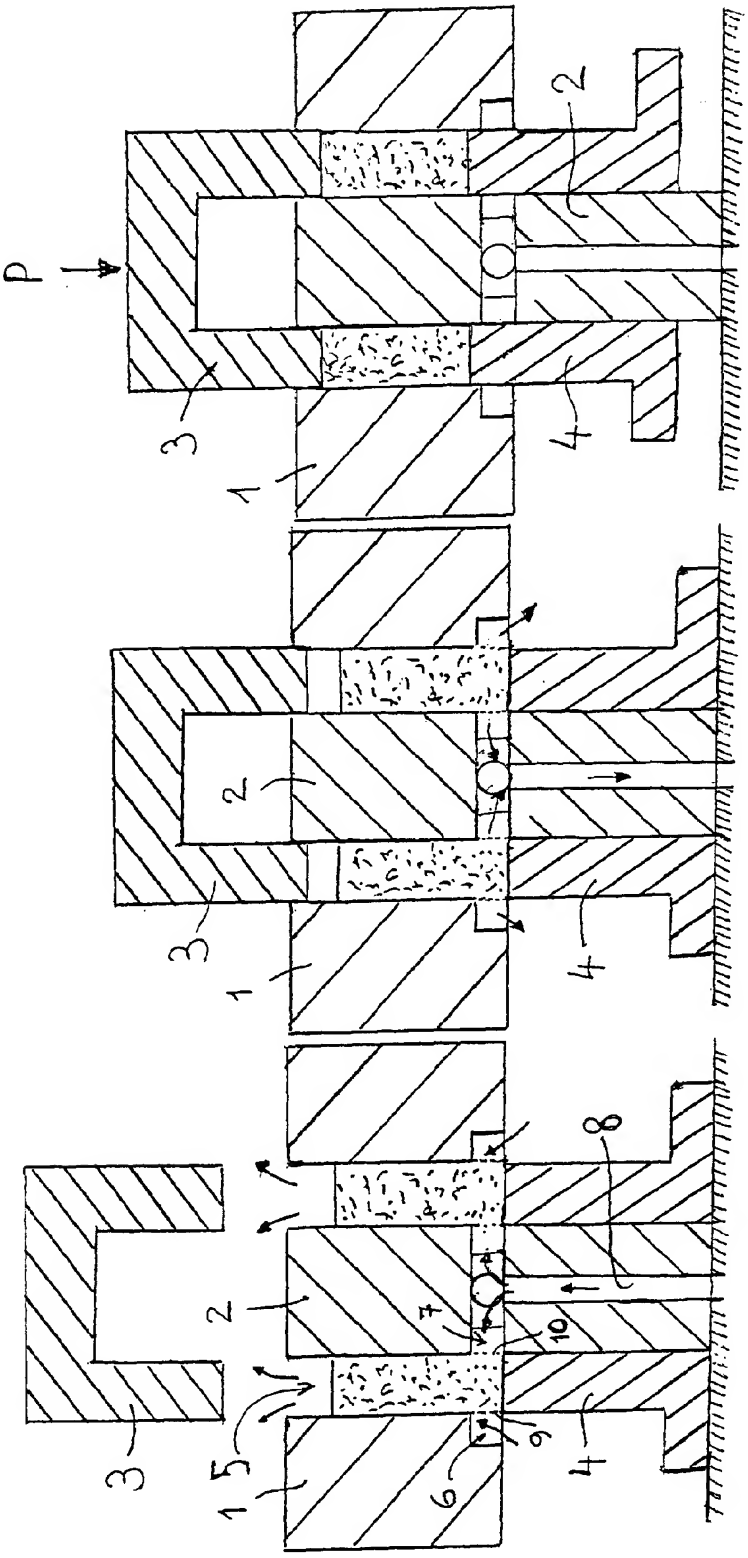

FIG. 3

FIG. 2

FIG. 1